



# HHS Public Access

Author manuscript

*Behav Res Ther.* Author manuscript; available in PMC 2018 January 01.

Published in final edited form as:

*Behav Res Ther.* 2017 January ; 88: 76–89. doi:10.1016/j.brat.2016.06.005.

## The effects of alcohol on emotion in social drinkers

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### Abstract

Understanding why people drink alcohol and in some cases develop drinking problems has long puzzled researchers, clinicians, and patients alike. In the mid-1940s and early 1950s, experimental research began to systematically investigate alcohol's hedonic properties. Presumably, alcohol consumption would prove reinforcing as a consequence of its capacity either to relieve stress or to brighten positive emotional experiences. This article reviews experimental research through the years examining the impact of alcohol on both the relief of negative affect and the enhancement of positive affect. It covers initial accounts that emphasized direct pharmacological effects of ethanol on the central nervous system. These early studies offered surprisingly tepid support for the premise that alcohol improved emotional states. Next, studies conducted in the 1970s are considered. Informed by social learning theory and employing advances derived from experimental psychology, this research sought to better understand the complex effects of alcohol on emotion. Coverage of this work is followed by discussion of current formulations, which integrate biological and behavioral approaches with the study of cognitive, affective, and social processes. These current perspectives provide insight into the particular conditions under which alcohol can boost emotional experiences. Finally, future research directions and clinical implications are considered.

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Examining the reasons that people use and misuse alcohol remains a research priority. For more than three-quarters of a century, experimental research has investigated alcohol's reinforcing properties. Allowing for subtle variation, the basic idea has been that alcohol consumption would prove reinforcing as a consequence of its capacity either to relieve stress or to enhance positive emotional experiences. Despite its intuitive appeal, however, by the early 1970s, reviews of this literature revealed surprisingly unreliable effects of alcohol on emotional states. Drawing upon advances taking place in behavior therapy, a new generation of investigators began to reshape this field of alcohol research. Their studies introduced cognitive and social factors to the study of alcohol and emotion, and added nuance to our understanding of alcohol's effects. This work in turn set the stage for subsequent investigators who developed social, affective, and cognitive models of alcohol use.

This paper offers a selective review of experimental research examining the impact of alcohol on both the relief of negative affect and the enhancement of positive affect in social drinkers. It covers initial drive-reduction accounts, followed by studies and conceptualizations that integrate social, emotional, and cognitive psychological concepts.

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Current research on positive affect and social bonding is summarized, and future research and clinical implications are addressed.

## 1. Negative affect relief

The idea that alcohol might be consumed to improve our darker moods has been apparent to poets, writers, and philosophers for millennia (Sayette, 1999a). Eventually this proposition was put to the test in the laboratory. Initial studies found that when intoxicated, animals—as diverse as rats and cats—experienced reduced experimental “neuroses” or conflict (Conger, 1951; Masserman & Yum, 1946). These data led to the development of what eventually became known as the tension reduction theory (TRT) (Cappell & Herman, 1972; Conger, 1956). This two-pronged theory, influenced by drive reduction learning-based models popular at the time (Dollard & Miller, 1950), posited that ingestion of alcohol reduces tension, presumably by directly affecting the central nervous system, and therefore that humans (and animals) consume alcohol to experience this effect. Alcohol’s putative effects on tension reduction became a core feature in Conger’s (1956) theory of alcoholism. Moreover, these tension-reducing properties were thought to underlie the disinhibition of a multitude of activities (e.g., aggressive or sexual behavior), suggesting even broader implications (Wilson, 1988a).

The TRT has received more scrutiny than any other psychological theory of alcoholism (Leonard & Blane, 1999). Surprisingly, though, by the 1970s it had become apparent that the TRT was unable to accommodate the inconsistent lab findings from both animal and human studies (Cappell & Herman, 1972; Marlatt, 1976). Wilson (1978) noted that “available evidence now clearly shows that there is no simple direct relation between the pharmacologic effect of alcohol and its behavioral consequences.” (p. 317). Even critics, however, seemed uncomfortable arriving at this conclusion. As Cappell (1975) acknowledged, this failure to support the TRT “... is perplexing since the rationale underlying the TRT seems so plausible and so consistent with commonplace experience” (p. 202). A new generation of alcohol researchers in the 1970s and 1980s set about to wrestle with this paradox; namely, how a theory held to be true by such a wide range of people could suffer from such inconsistent experimental support. At the forefront of this movement were Alan Marlatt at the University of Washington and G. Terence Wilson at Rutgers University. While Marlatt’s work tended to emphasize the processes associated with drinking and relapse (the second hypothesis related to the TRT), Wilson’s research focused on the first hypothesis derived from the TRT, examining the impact of alcohol on stress,<sup>1</sup> and is discussed next.

### 1.1. Social learning theory of alcohol use and abuse

Wilson’s TRT research was influenced by several factors drawn from experimental psychology. He entered the alcohol field already an established leader in the burgeoning behavior therapy movement, and in particular he was a persuasive advocate for social learning theory (subsequently recast as cognitive social learning theory). From a social

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<sup>1</sup>In addition to his research on social anxiety, Wilson also investigated the impact of alcohol on sexual arousal (e.g., Wilson, 1981).

learning perspective, drinking offers a way of coping with life's demands that can become maladaptive if excessively used (Abrams & Niaura, 1987). Like Marlatt (e.g., Marlatt, 1978), Wilson was interested in the theories and research of Walter Mischel (1968), and especially of Albert Bandura (e.g., Bandura, 1969; 1977; 1986). Bandura critiqued existing approaches to alcoholism that focused on single personality traits, psychodynamic conflicts, and physiological drive-reduction formulations of TRT, in favor of an approach that emphasized learning (e.g., differential reinforcement), social influences (e.g., modeling), and cognitive processes (e.g., expectancy, self-efficacy). Alcohol use was thought to be reinforced differentially according to the circumstances surrounding consumption, which was a departure from prior TRT formulations that targeted more narrowly the pharmacological properties of ethanol. Wilson (1978; 1988b) argued that alcohol abuse was largely governed by the same principles that regulated non-pathological behavior. While there had been a number of laboratory analogue studies in the 1960s and early 1970s examining the emotional impact of alcohol using alcoholic samples (see Langenbucher & Nathan, 1990), Wilson believed that a comprehensive theory of alcohol consumption also needed to explain normal drinking, and moreover that studying social drinkers held promise for understanding problem drinkers. Indeed, in many respects social drinking participants offer cleaner tests of the effects of alcohol than do alcohol dependent participants, as the latter individuals often present with a range of social, medical (including psychiatric), and economic complications. Social drinkers also are unlikely to experience withdrawal from alcohol. Consequently, acute effects of alcohol can be studied in this population independent of the effects of withdrawal relief [See Baker, Piper, McCarthy, Majeskie, and Fiore (2004) for a reformulated negative reinforcement model of alcohol and drug use that emphasizes escape or avoidance from withdrawal.]. Accordingly, Wilson's research examining TRT was conducted using social drinking participants.

Wilson was instrumental in introducing novel conceptual and methodological approaches to reconsidering the TRT. Chief among these insights were the need for methodological rigor (with particular focus on the assessment of anxiety), the importance of context, and the value of incorporating cognitive psychological factors.

**1.1.1. Anxiety assessment**—Both Wilson (1978; 1982) and Marlatt (1976) voiced concern that too many TRT studies relied exclusively on single self-reported anxiety scales. Wilson criticized this approach on both conceptual and empirical grounds. Conceptually, by the mid-1970s researchers associated with both the behavior therapy (e.g., Hodgson & Rachman, 1974) and the basic emotion (e.g., Lang, 1971) fields had concluded that anxiety is most comprehensively captured when indexed across multiple response systems, including measures of behavior, psychophysiological arousal, and self-reports of distress. Wilson (1978) observed that alcohol-related changes in one response system need not be associated with changes in another and noted that “these different dimensions of anxiety may be differentially responsive to different forms of influence and change at different speeds” (p. 322). The sole reliance on a self-report anxiety scale left too much information unexamined. Empirically, Wilson and colleagues conducted a number of studies in which the effect of alcohol differed across these different response systems. For instance, in some studies physiological data were sensitive to the effects of alcohol, while self-report or behavioral

measures were not (e.g., Sayette & Wilson, 1991; Wilson, Abrams, & Lipscomb, 1980). Moreover, these response domains appeared to be differentially sensitive to participants' particular response styles (e.g., social desirability; Sayette, Contrada, & Wilson, 1990). Use of one type of anxiety measure offered an incomplete analysis of the impact of alcohol.

**1.1.2. Social context**—Wilson was interested in the role of social factors when evaluating the variable effects of alcohol on behavior. According to Wilson (1982), some of the equivocal TRT evidence was due to poorly validated, asocial paradigms that lacked clinical utility. In particular, many studies had used an electric shock stressor to elicit anxiety. He argued that a shock threat elicited a response that was fundamentally distinct from the anxiety associated with an interpersonal evaluation; therefore physical and social stressors might not be associated with alcohol in a similar fashion. This observation was in accord with Higgins and Marlatt's (1973; 1975) studies and his own clinical research revealing the importance of interpersonal interactions on alcoholic drinking (Lawson, Wilson, Briddell, & Ives, 1976). To be clinically meaningful, Wilson advocated conducting TRT studies that induced social anxiety.

In place of electric shock, Wilson adopted a social evaluation paradigm developed by Borkovec, Stone, O'Brien, and Kaloupek (1974). These investigators instructed male participants to make a favorable impression on an unresponsive female confederate. Participants were informed that the interaction would be videotaped and rated by experts on a variety of psychological characteristics. In addition to examining the effects of drinking on the affective state of the participant, Wilson also considered the drinking status of the partner to be relevant to the experience of anxiety. For instance, men seemed more relaxed if they believed their female partner had been drinking alcohol than if he thought she were sober (Wilson, Perold, & Abrams, 1981). This focus on social paradigms was consistent with a tenet of social learning theory positing that the effects of alcohol varied as a function of the context in which it was consumed.

**1.1.3. Cognitive factors**—In critiquing the extant TRT literature, Wilson observed that much of the research to date had ignored cognitive expectancy factors. The cognitive revolution that swept across psychology in the 1970s had begun to influence psychopathology research, including addiction (see Sayette, 1999b; Tiffany, 1991; Wilson, 1987a). Along with Marlatt (e.g., Marlatt, 1976; 1978), Wilson argued that one's beliefs about the effects of alcohol, developed over time through both direct and vicarious experiences, materially influenced the impact of drinking on anxiety. He proposed that these cognitive expectancies regarding the anticipated effects of alcohol would necessarily vary across individuals as a result of their social learning histories, and within individuals would differ across settings and times (Wilson, 1978). His laboratory investigations, using state-of-the-science placebo deception methods (e.g., strong mouthwash, wiping alcohol on the rim of the glass, false BAC feedback), dovetailed with survey research observing associations between endorsements of particular alcohol expectancies and drinking patterns across a diverse sampling of individuals (Brown, Goldman, Inn, & Anderson, 1980; Goldman, Brown, & Christiansen, 1987).

In contrast to existing pharmacological theories linking TRT to depressant effects of alcohol, Wilson's research emphasized drinking expectancies. His early studies used a low dose of alcohol and the balanced placebo factorial design that had been popularized by Marlatt (e.g., Marlatt, Deming, & Reed, 1973), in which ethanol content and instructions regarding the alcohol content of the beverage were orthogonally manipulated. These studies suggested that when low doses of alcohol were administered, the belief that one is consuming alcohol may exert a greater effect than the drug itself (e.g., Abrams & Wilson, 1979; Wilson & Abrams, 1977).<sup>2</sup> Moreover, factors such as one's gender were thought to interact with these expectancy effects (Wilson et al., 1981). Rather than ruling out the possibility that alcohol ingestion (e.g., at more moderate doses) could affect anxiety, these studies were pivotal for underscoring the position that comprehensive accounts of drinking ought to account for more than simply pharmacological effects of ethanol consumption. More recently, there has been interest in integrating pharmacological and expectancy factors. For instance, tension-reducing expectancies are more likely to be endorsed while blood alcohol levels are at peak than while they are dropping (Kushner et al., 2000).

Once psychological expectancy factors were considered, consistent with social learning theory, Wilson suggested that the TRT becomes a far more complex theory influenced by a range of pharmacological (e.g., dose, physiological responsiveness to alcohol), psychological (e.g., social learning histories, learned expectations about the effects of alcohol), individual differences (e.g., gender), and social factors (e.g., the immediate setting in which drinking occurs). His biopsychosocial analysis of this literature offered a template for the next several decades of alcohol research on emotion: "In view of the influence of all these psychosocial and pharmacological factors on the relationship between alcohol and anxiety, it is simply no longer useful to ask the question: Does alcohol reduce tension? In terms of social learning theory, the more meaningful question to pose is: Under what conditions, at which doses, in whom, on what measures, and how does alcohol affect specific forms of tension?" (Wilson, 1982, p. 124). This approach was more comprehensive than traditional TRT models and set the stage for a proliferation of theory and research into the effects of alcohol on emotion.

## 1.2. Stress response dampening

Shortly after the initial alcohol studies by Wilson and Abrams (1977; Abrams & Wilson, 1979), Levenson, Sher, and their colleagues began publishing research that sought to further clarify the TRT (e.g., Levenson, Oyama, & Meek, 1987; Levenson, Sher, Grossman, Newman, & Newlin, 1980; Sher & Levenson, 1982; Sher & Walitzer, 1986; Sher, Bartholow, Peuser, Erickson, & Wood, 2007). Applying advances in emotion and in psychophysiological research, these investigators argued that the term "tension", with its historical baggage dating back to psychodynamic and drive-reduction models, be replaced with a pared-down term, which remains in use to this day. *Stress response dampening* refers to a "reduction in the magnitude of the response to stress" (Levenson et al., 1980, p. 536, p. 536).<sup>3</sup> In their view, tests of stress response dampening required alcohol studies to present

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<sup>2</sup>At higher doses Wilson noted that alcohol appeared to exert more of a pharmacological effect (see Caudill et al., 1987).

<sup>3</sup>To enhance consistency throughout the paper I continue to refer to the tension reduction theory to describe alcohol studies associated with the reduction of stress or anxiety.

participants with an explicit (and validated) stressor. In response to the early studies by Wilson and others, these investigators also used placebo, and in some instances balanced placebo, designs to examine both pharmacological and expectancy effects. Interestingly, when higher doses of alcohol were used than in the original Wilson and Abrams (1977; Abrams & Wilson, 1979) studies, their findings suggested a primarily pharmacological effect on stress response dampening<sup>4</sup> (see also Donohue, Curtin, Patrick, & Lang, 2007).

Sher and Levenson brought an increasingly comprehensive and sophisticated approach to physiological assessment and analysis that took into account just how rapidly stress experiences can shift throughout a single stressor administration. For example, the stress response associated with a self-disclosing speech seems to peak while the participant anticipates speaking and just after speech onset, suggesting the need for time-sensitive assessments that previously had been neglected when self-report anxiety instruments were administered at just one time point (see also Levenson, 1987; Sayette, Smith, Breiner, & Wilson, 1992). Sher and Levenson also recognized the need to recruit larger samples than had been the norm in order to adequately test their hypotheses. These larger studies helped to put an end to the era of TRT research in which cell sizes for the various experimental groups often were less than 10 participants, a likely obstacle to replication. Their stress response dampening studies included both physical (threat of shock) and social stressors (e.g., making a self-disclosing speech), and across their studies—and sometimes within their studies (e.g., Sher & Walitzer, 1986)—they tested multiple doses of alcohol.

Perhaps most importantly, Sher and Levenson investigated a range of individual difference variables (e.g., family history of alcoholism, personality traits thought to be associated with the development of alcoholism) that might moderate the stress response dampening effects of alcohol (see Sher & Wood, 2005). Individuals differ markedly in their response to alcohol and, as chronicled by Sher, Trull, Bartholow, and Vieth (1999), the possibility that one's sensitivity to the effects of alcohol might offer etiologically significant information dates back more than a century. Presumably, persons experiencing the greatest stress response dampening effects of alcohol would be most vulnerable to developing drinking problems. These studies helped to clarify the conditions under which alcohol might reduce stress responding, and suggested individual difference variables that might moderate these effects. Still left open were social and cognitive explanations for the mechanisms underlying stress response dampening (Levenson et al., 1980).<sup>5</sup> Starting in the 1980s and continuing to the present, theorists have aimed to examine such social and cognitive mechanisms that mediate alcohol's anxiolytic effects, with an eye toward identifying the circumstances under which alcohol is most likely to reduce stress.

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<sup>4</sup>Subsequent research by Wilson and colleagues that used more moderate doses of alcohol than in the earlier studies by Wilson and Abrams (1977; Abrams & Wilson, 1979) also failed to observe expectancy effects (e.g., Sayette, Breslin, Rosenblum, & Wilson, 1994). More broadly, as research has accumulated, the initial effects of placebo beverages to reduce anxiety have been hard to replicate (Greeley & Oei, 1999).

<sup>5</sup>Although Levenson et al. (1980; Levenson, 1987) did not outline a theory by which alcohol's effects on cognition affected stress response dampening, they explicitly noted this possibility.



### 1.3. Self-awareness

According to Jay Hull (1981, 1987), alcohol's TRT properties are cognitively mediated. By impairing the encoding of information in terms of its self-relevance, alcohol intoxication reduces self-awareness. The inhibition of encoding processes serves to reduce performance-based self-evaluation, which in situations where such evaluation is unpleasant, will attenuate stress responses, thus heightening the probability of drinking. Hull's (1987) position that alcohol inhibits the processing of information as self-relevant has been tested through efforts to reveal that alcohol interferes with the use of self-focused statements during a speech and that persons who are high in self-consciousness (Fenigstein, Scheier, & Buss, 1975) are more sensitive to alcohol's anxiolytic effects.

While support has been mustered (Fairbairn, Sayette, Levine, Cohn, & Creswell, 2013; Hull & Reilly, 1983; Hull, 1981, 1987; Hull, Young, & Jouriles, 1986), so too have data emerged that were inconsistent with the self-awareness model (Caudill, Wilson, & Abrams, 1987; Chassin, Mann, & Sher, 1988; Frankenstein & Wilson, 1984; Wilson, 1983). For example, Hull, Levenson and Young (1981, unpublished manuscript cited in Hull, 1987) found that during a speech stressor, alcohol blunted the increased arousal experienced by highly self-conscious drinkers more than it did for participants low in self-consciousness, while others have failed to find a relationship between self-consciousness and anxiety relief (Niaura, Wilson, & Westrick, 1988; Sher & Walitzer, 1986). As noted elsewhere (Hull & Reilly, 1983; Sayette, 1993a) a difficulty in testing self-awareness levels is the possibility that probes for self-awareness (e.g., Yankofsky, Wilson, Adler, Hay, & Vrana, 1986) may influence the cognitive processes being measured.

### 1.4. Attention-allocation

Claude Steele and colleagues proposed what has become an influential cognitive model to explain the inconsistent evidence for TRT. As with the self-awareness model, the attention-allocation model—eventually subsumed under alcohol myopia theory (Steele & Josephs, 1990)—posits that alcohol influences stress indirectly through its impairment of cognitive processing (Josephs & Steele, 1990; Steele & Josephs, 1988; Steele, Southwick, & Pagano, 1986). Alcohol's purported “narrowing of perception” to immediate stimuli and its attenuation of cognitive abstracting capacity limits attention to the most immediate, salient aspects of experience (see also Taylor & Leonard, 1983). Accordingly, the concurrent activity in which an intoxicated drinker engages serves to determine the effects of alcohol. Intoxication during concurrent distraction is thought to weaken stress responding, whereas, without a neutral or pleasantly distracting activity, intoxication is not predicted to generate stress relief, and may even increase anxiety by focusing attention on the then-salient stressor.

Tests of the attention-allocation model revealed that alcohol in tandem with a pleasant distraction diminished self-reported anxiety associated with stressor administrations, such as negative feedback from a test (Steele et al., 1986) and anticipating the presentation of a self-disclosing speech (Josephs & Steele, 1990; Steele & Josephs, 1988). Without distraction, however, alcohol did not reduce (Josephs & Steele, 1990; Steele et al., 1986), and even increased (Steele & Josephs, 1988) anxiety. To obtain more direct evidence regarding the attention-allocation model, Josephs and Steele (1990) employed a secondary response time

task to assess the amount of attention available during varying levels of intoxication and distraction. When participants had increased attentional capacity (when they were sober and/or not distracted) they reported greater levels of anxiety while anticipating the speech. In contrast, when participants were intoxicated and/or distracted, anxiety levels dropped and response time rose, suggesting less available cognitive capacity to focus on the stressor (Josephs & Steele, 1990; see Sher et al., 2007 for a conceptual replication using skin conductance level to assess stress). Other research has aimed to unpack the construct of attention and suggests that the underlying cognitive mechanism associated with intoxication relates to the ability to allocate attention, rather than with the amount or scope of information that can be simultaneously attended (Saults, Cowan, Sher, & Moreno, 2007).

Though compelling, the studies by Steele et al. did not assess cognitive processing and emotion simultaneously (see Sayette, 1993a). Curtin, Patrick, Lang, Cacioppo, and Birbaumer (2001) used event-related potentials and fear-potentiated startle measures to address this limitation. Consistent with the attention-allocation model (and other cognitive theories such as the appraisal-disruption model, discussed next), their findings provided evidence that alcohol's impairment of cognitive processing can influence emotional responding.

More recently, we used unobtrusive real-time measures (continuous facial coding of smiles coded over consecutive 10-s bins) during a social interaction and autocorrelation analyses—a measure of temporal dependency that examines the relation between past and present affective experience (Jahng, Wood, & Trull, 2008)—to test a key tenet of the attention-allocation model. This model proposes that alcohol creates a myopic focus on the present moment, thereby limiting the degree to which present experiences are influenced by emotions derived from prior experience (Fairbairn & Sayette, 2013). Consistent with the theory, alcohol reduced affective autocorrelation (emotional inertia), and autocorrelation mediated the link between alcohol and self-reported mood, suggesting that alcohol increases the ability to experience the present moment unbound by past experience. Using different methods, Fleming et al. (2013) also found support for this aspect of the attention-allocation model, namely that alcohol enhances the salience of recently appraised information.

In sum, the attention-allocation model has inspired multiple replications of the core finding that in the presence of concurrent distraction, a moderate dose of alcohol will reduce self-reported anxiety. Because most of the drinking that occurs in the real world includes distractions, a major attraction of the attention-allocation model is that it provides a mechanism to explain why alcohol often will provide anxiolytic effects (Josephs & Steele, 1990). Although it is difficult to reconcile Steele and colleagues' data with those of studies that have found anxiolytic effects in the absence of distraction (see Sayette, 1993a, table 1), the attention-allocation model nevertheless offers a plausible explanation for both the anxiolytic and anxiogenic effects of alcohol.

### 1.5. Appraisal-disruption

Sayette (1993a) proposed an appraisal-disruption model of alcohol that, like the self-awareness and attention-allocation models, emphasized effects of alcohol on cognition. According to this model, intoxication impairs the cognitive processes associated with the



appraisal of new information. Specifically, alcohol may impede the initial perception of stressful information by preventing the activation of associated stressful memories and concepts. This view is consistent with a number of studies that have found alcohol to impair organizational processes (see Sayette, 1993a). The appraisal-disruption model emphasizes the match between the complexity of the stressor and the appraisal processing resources available during encoding. Complex stressors that are difficult to appraise provide optimal conditions for stress relief (see also Curtin, Lang, Patrick, & Stritzke, 1998). In addition, when intoxication precedes exposure to a stressor, weakened appraisal may buffer stress by protecting the drinker from fully experiencing the stressor. If the stressor already has been appraised sufficiently to elicit stress, however, subsequent drinking may no longer inhibit that stress—unless, consistent with the attention-allocation model, one were to become distracted by friends or other stimuli and “forget” his or her own discomfort.

A review of TRT studies provided support for the temporal sequencing prediction associated with the appraisal-disruption model (Sayette, 1993a). Among studies in which participants consumed alcohol before learning of an upcoming stressor, data consistently revealed that alcohol reduced stress. In contrast, alcohol’s effects varied (i.e., alcohol increased, decreased, or had no effect on stress) in studies in which investigators informed participants about the stressor before providing alcohol. Furthermore, several studies explicitly manipulated within a single experiment the degree of stressful information provided to participants prior to intoxication. These studies supported the hypothesis derived from the appraisal-disruption model that alcohol’s anxiolytic effects should be more apparent when appraisal follows, rather than precedes, intoxication (Noel, Lisman, Schare, & Maisto, 1992; Sayette & Wilson, 1991; Sayette, Martin, Perrott, Wertz, & Hufford, 2001b; Sayette, Wilson, & Carpenter, 1989).

To test the cognitive processes thought to underlie the appraisal-disruption model, we used a pair of cognitive response time tasks to test the effects of alcohol. A color-naming Stroop task evaluated the hypothesis that when consumed prior to stress appraisal (i.e., anticipating making a self-disclosing speech), alcohol would reduce stress-related interference. Consistent with this hypothesis, data revealed that when alcohol was administered before (but not after) stress appraisal, alcohol reduced interference to threatening words (Sayette et al., 2001b). We also tested the effects of alcohol on spreading activation using a mediated semantic priming task, in which target words were preceded by primes that were either unrelated or indirectly related to the target (e.g., “lion” indirectly primes “stripes” via “tiger”). Consistent with the position that alcohol constrains the spread of activation of associated information in memory, intoxicated participants without a family history of alcoholism displayed reduced mediated priming effects (Sayette, Martin, Perrott, & Wertz, 2001a).<sup>6</sup>

The appraisal-disruption model accommodates many of the apparently contradictory findings reported in past investigations (Sayette, 1993a). Specifically, the model offers an explanation for why only some experiments detect anxiolytic effects of alcohol.

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<sup>6</sup>See Sayette et al., 2001a for discussion of the pattern of data observed among the minority of participants in the study with a family history of alcoholism.

Nevertheless, methodologically it is difficult to conduct research on this model, as studies are hard-pressed to avoid informing participants of a stressor at the study outset. Further, though there is some evidence to suggest that alcohol may be particularly likely to inhibit appraisal of negative information in psychologically healthy drinkers (Sayette, 1994; see also; Bartholow, Pearson, Gratton, & Fabiani, 2003), the appraisal-disruption model does not settle the question regarding which types of information are most sensitive to alcohol's effects (Lang, Patrick, & Stritzke, 1999; Sayette, 1993a). One approach to examining the types of aversive stimuli most sensitive to the effects of alcohol has been systematically addressed in recent years by John Curtin, and is discussed next.

### 1.6. Threat predictability

In the years since the self-awareness, attention-allocation, and appraisal disruption models have appeared, improved theory and methods in both the behavioral and neurobiological study of emotion and cognition permit more refined investigation of the impact of alcohol on stress (see Curtin & Lang, 2007; Lang et al., 1999). Curtin and colleagues proposed that alcohol's effects on negative affective states are not uniform. In particular, they made differential claims regarding the impact of alcohol on fear versus anxiety (Moberg & Curtin, 2009). Based on research demonstrating that these two affective states have distinct neurobiological substrates, they drew upon a large body of animal and human neuroscientific and psychophysiological research to argue that the crucial distinction concerns the degree to which a stressor is predictable. Their research using an electric shock stimulus indicates that alcohol may reduce anxiety (when outcomes are unpredictable) but not fear (when outcomes are predictable).

Across an impressive array of studies focused on factors related to the certainty of stressor occurrence, timing, and intensity, Curtin et al. used precisely timed stimuli and a multimodal stress response assessment battery to demonstrate that alcohol reduces stress in a dose response fashion when future events are uncertain or unpredictable, but exerts little impact on negative emotions associated with highly probable negative events (Bradford, Shapiro, & Curtin, 2013; Hefner & Curtin, 2012; Hefner, Moberg, Hachiya, & Curtin, 2013; Moberg & Curtin, 2009). Moreover, they identified potential individual-difference factors (e.g., binge drinking history, negative emotionality) that may moderate alcohol's anxiolytic effects (Bradford et al., 2013; Hefner et al., 2013). Another feature of this research program is the degree to which the mechanisms of stimulus certainty or predictability have been contrasted across drugs of abuse (Hefner, Starr, & Curtin, 2016; Hogle, Kaye, & Curtin, 2010). The appeal of the shock threat paradigm is that there is more control over factors such as predictability than one would expect using more unwieldy social interaction manipulations. Nevertheless, as has been discussed by Marlatt (1978) and Wilson (1982), there may be critical distinctions between electric shock and social stressors. Accordingly, as Curtin and colleagues recognized, future research using a broad array of aversive stimuli is indicated to investigate the precise appraisal and attentional processes, as well as the neurobiological mechanisms, that underlie response to uncertain threats (see Bradford et al., 2013; Hefner et al., 2013). As the next section suggests, however, there is reason to think that the findings from Curtin's laboratory may generalize to social settings.

### 1.7. Social-attribution

Fairbairn and Sayette (2014) recently outlined a social attributional framework for examining the impact of alcohol on social anxiety, and on emotion more generally. Based on principles of stability and internal/external causality from attribution theory (Heider, 1958; Rotter, 1966; Weiner, 1985), this approach proposes that alcohol's effects are largely explained by its tendency to free individuals from preoccupation with social rejection, allowing them to access social rewards. This framework builds on the work of Curtin, Hull and their colleagues to suggest that alcohol will enhance mood when negative outcomes are perceived to be unstable and/or self-relevant (e.g., meeting strangers at a bar). It identifies a novel methodological factor to explain inconsistent alcohol-administration findings, "distinguishing between studies featuring unscripted interactions among naïve participants ... and those featuring scripted social interactions with individuals identified as study confederates" (Fairbairn & Sayette, 2014, p. 1361). While nearly all naïve-participant studies reveal positive effects of alcohol on emotion, only a small minority of confederate studies find evidence of significant alcohol-related emotional enhancement. The naïve-participant versus confederate distinction holds even after adjusting for potential moderators including stress manipulations, gender, group size, anxiety outcome measure, and within-group consistency of beverage assignment (Fairbairn & Sayette, 2014).

The social-attributional approach integrates distinct concepts drawn from several theories of alcohol's effects. It addresses the large body of research that utilized social interactions to induce stress, providing a rationale for why alcohol may be more effective in reducing stress when such interactions are unscripted. In addition to clarifying the type of studies likely to support the TRT, it presents promising lines of inquiry for future research examining the role of social factors in alcohol reward, which is addressed next.

## 2. Emotional enhancement

Although the majority of alcohol—emotion research has examined TRT, so too have investigators been interested in understanding the capacity of alcohol to enhance positive emotional states (Lang et al., 1999). Presumably, consumption of a drug that consistently bolsters positive affect should prove positively reinforcing. Similar to the logic underlying the TRT (see Sher, 1987) individuals who gain the greatest pleasure and reward from alcohol ought to be most at risk for developing a subsequent drinking problem (Fairbairn et al., 2015c). Survey data offer robust evidence that people drink in part to enhance their social and emotional experiences (Brown et al., 1980; Cooper, Russell, Skinner, & Windle, 1992). As with the TRT, however, laboratory findings regarding positive emotional enhancement have proven to be inconsistent (Sayette, Fairbairn, & Creswell, 2016). Although some research suggests that alcohol consumed in an isolated laboratory setting can induce elation [e.g., while on the ascending limb of the BAC curve (Lukas & Mendelson, 1988; Martin, Earleywine, Musty, Perrine, & Swift, 1993)] many other studies using both social drinking and alcoholic participants have been less successful in observing emotion-enhancement effects (see Sher, 1987).

Just as Wilson (1982) argued that social interactions in the laboratory offered clinically meaningful contexts for studying TRT, the same appears to be true when investigating

positive emotional states (Kalin, McClelland, & Kahn, 1965; Russell & Mehrabian, 1975; Sher, 1985; Sher, Wood, Richardson, & Jackson, 2005; Williams, 1966). The inclusion of a social context when studying the emotional effects of alcohol makes particular sense when one realizes that since the mid-1970s, the vast majority of participants recruited for alcohol administration studies are social drinkers who report rarely drinking alone. Surprisingly, however, these social drinking participants often find themselves drinking in isolation in the laboratory (Fairbairn & Sayette, 2014). In a study that should have done more to reposition the field, Pliner and Cappell (1974) contrasted the effects of alcohol while consumed alone to those observed while in groups. Participants drinking in groups reported and displayed changes that were primarily emotional (e.g., feeling less unhappy), while those consuming alcohol in isolation reported primarily physiological changes (e.g., feeling dizzy). Subsequent research (e.g., Doty & de Wit, 1995; Kirchner, Sayette, Cohn, Moreland, & Levine, 2006; Kirkpatrick & de Wit, 2013; Samson & Fromme, 1984) also supported the view that testing alcohol's effects requires a social context.

The few alcohol studies conducted in groups have yielded mixed findings, however, likely due in part to methodological limitations (for elaboration see Sayette et al., 2012a). Chief among these concerns, studies have lacked sufficient power to address group-level processes. Moreover, they have arbitrarily varied the size of the groups and failed to determine whether group members were previously acquainted. Other concerns with studies examining alcohol and positive emotion mirror limitations noted by Wilson when critiquing TRT research. To wit, many prior studies have neglected to include appropriate beverage control conditions to account for both the potential pharmacological and dosage-set effects of alcohol (for elaboration on dosage-set methods and findings, see Martin & Sayette, 1993). In addition, past studies have tended to rely too heavily on self-report measures of emotion, neglecting comprehensive, multimodal assessments.

Finally, the mixed findings regarding alcohol's impact on positive affect may result from a failure to consider the small groups research literature, which recognizes the hierarchical structure of group data and the importance of accounting for both quantity and coordination of behaviors (Sayette et al., 2012a). Small-groups researchers emphasize that a group is not merely a collection of individuals but is a distinct entity unto itself (Levine & Moreland, 1998). Accordingly, one cannot merely assume that the default unit of analysis is the person. Methodologically, group dynamics research has employed observational measures that permit unobtrusive real-time measurement of socio-emotional experience that extend beyond what typically has been used to observe social interaction in the TRT studies addressed above. For instance, advances in capturing multiple streams of dynamic behavior (e.g., Bakeman, 1999), have provided measurement of group-level interactive and coordinated responses.

## 2.1. Group formation project

Consistent with the findings of Pliner and Cappell (1974), my colleagues and I have been guided by the premise that to comprehensively identify the effects of alcohol on positive affect in social drinkers, one must evaluate such participants in a social context (Sayette et al., 2012a). Further, in light of the reliably observed effects of alcohol in unstructured social

interactions and the inconsistent data found during scripted interactions employing confederates (Fairbairn & Sayette, 2014), our approach investigates the impact of alcohol on initial group formation using groups of unacquainted participants interacting in an unscripted setting. In addition to recruiting groups of strangers, our research methods diverge in several important ways from the bulk of research examining the hedonic effects of alcohol.

In contrast to TRT research that employed a specific stimulus (a stressor) to create a proper environment for examining the anxiolytic effects of alcohol (Sher, 1987), we decided not to use a discrete stimulus to elicit an emotional reaction. Instead, unstructured interaction among strangers was presumed to elicit both positive (e.g., associated with social bonding) and negative (e.g., associated with social anxiety) emotional reactions (Leary & Kowalski, 1995). As in real life drinking settings, shifts in emotional valence and intensity can occur continuously and naturally during group formation, offering a different environment than that found in many studies administering discrete emotional provocations. We sought to model the type of experience a college student might have upon entering a fraternity party. One moment an acquaintance saunters by and ignores the student, leading to a momentary wave of discomfort, if not mortification. Seconds later, however, a smiling classmate who was not expected to attend the party, strides over and initiates a friendly discussion. This rollercoaster of emotion is not uncommon in drinking settings, yet is rarely captured in alcohol studies. We also opted to study the emotional effects of alcohol *while* participants were drinking. This differs from the vast majority of studies that administer the alcohol followed by an absorption period (both occurring in isolation) prior to initiating the social interaction. Our view was that in most social drinking settings the interaction and the drinking occur simultaneously rather than sequentially. Moreover, this approach permits testing of the effects of alcohol while blood alcohol concentrations are rising steeply.

To test alcohol's effects during group formation in real-time, we used the Facial Action Coding System (FACS; Ekman, Friesen, & Hager, 2002). FACS identifies facial expressions, or action units, thought to relate to emotion (Ekman & Rosenberg, 2005), and is the most reliable and comprehensive facial coding system. In addition to several action units that had previously been linked to negative emotions (see Sayette et al., 2012a for elaboration) we focused on the most widely studied positive emotion-related expression in FACS, the Duchenne-smile (e.g., Ekman, Davidson, & Friesen, 1990; Hess, Banse, & Kappas, 1995). [The Duchenne smile involves contraction of both the zygomaticus major (raising the corners of the mouth) and orbicularis oculi (raising the cheeks and producing crow's feet around the eyes) muscles, whereas a non-Duchenne-smile involves only contraction of the zygomaticus major muscle]. In addition to facial expression, we also examined content-free speech patterns, which can reflect emotional states and social processes (Dabbs & Ruback, 1984; Leary & Kowalski, 1995). Finally, the study included self-report measures of affect and social bonding collected just after the interaction.

The experimental methods and basic findings are reported in Sayette et al. (2012a). Briefly, 720 healthy male and female social drinkers 21–28 years old were randomly assigned to groups of three. To ensure that participants were unacquainted, four or five people were invited to each session and only three were used. They were told that they would drink

together in one room to increase efficiency and that they next would be separated to complete the main part of the study, ostensibly dealing with cognitive processing. This design generated 240 three-person groups randomly assigned to one of three beverage conditions with all group members drinking the same type of beverage: alcohol (a moderate gender and weight adjusted dose), placebo (participants told they were consuming alcohol but actually drank a nonalcoholic beverage), and a no-alcohol control condition (participants told and received a nonalcoholic beverage “juice”). Each beverage condition contained 20 groups representing each of the four possible gender compositions (all females, two females and one male, one female and two males, all males).

Participants drank their beverages together over a 36-min period (the free interaction period). The drinking session was recorded using a digital video control system. Following drinking, participants completed a self-reported social bonding measure. Each frame (1/30<sup>th</sup> of a second) of the interaction was manually evaluated by FACS-certified coders blind to experimental condition for relevant facial action units (more than 30-million frames of video were coded).

Results offered wide-ranging support for the premise that a moderate dose of alcohol enhances positive affect and social bonding.<sup>7</sup> During group formation, alcohol-drinking groups experienced more social bonding than did groups drinking non-alcoholic beverages. This result would appear to be especially important; the need to belong and to bond with others is widely held to be a powerful motivating force (Baumeister & Leary, 1995). Furthermore, these robust effects appeared at both individual and group levels of analysis. At the individual level, alcohol increased Duchenne-smiling. Alcohol also increased time participants spent speaking to one another (and reduced moments of silence) and self-reported bonding (Sayette et al., 2012a).

We also tested how well group members coordinated their expressive behavior. After controlling for overall smiling, alcohol enhanced “golden moments,” when all three group members simultaneously evinced the Duchenne-smile. Alcohol also increased the likelihood that all three group members would speak sequentially. These findings appeared to be driven by pharmacological rather than dosage-set influences, as placebo and control groups tended to show similar responses that differed from alcohol groups (Sayette et al., 2012a). Subsequent acoustical analyses of decibel levels during the group interaction offered further evidence that alcohol enhanced positive affect (Fairbairn et al., 2015b).

This broad evidence of alcohol’s emotion-enhancing effects during group formation stands in contrast to the equivocal findings of prior alcohol administration studies. These findings likely are due to several factors, including testing participants in a social context, using observational measures to unobtrusively capture momentary naturally-occurring fluctuations of both positive and negative emotional responses, and recruiting a large sample that offered adequate statistical power to conduct both individual-and group-level analyses that accounted for interdependence of group members (Sayette et al., 2012a). Though it is reassuring to find emotion-enhancing effects of alcohol in the laboratory that square with

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<sup>7</sup>Results of the study also indicated that alcohol consumption attenuated negative affect (Sayette et al., 2012a).



conventional wisdom, as well as with survey data, by itself the findings reported in Sayette et al. (2012a) were not especially provocative. Its chief contribution may have been to offer validation for these methods (i.e., the group formation interaction period coupled with the multimodal collection of measures of affect and bonding) to examine the effects of alcohol on emotion. This group formation paradigm can address two objectives of laboratory research in this area: to evaluate in a controlled experimental setting potential mechanisms (mediators) underlying the putative mood-enhancing effects of alcohol; and to reveal individual difference variables that might moderate these effects of alcohol.

## 2.2. Mediators and moderators of alcohol's effects during group formation

As noted by Wilson (1982) and Sher (1987), a major objective of TRT research has been to investigate both the underlying mechanisms mediating alcohol's effects on emotion and the conditions under which alcohol is reinforcing, including understanding in whom the effects are most pronounced. Several mediators have been proposed to explain alcohol's effects on emotion, including some that stem directly from the various models discussed earlier when addressing TRT (see Sayette et al., 2016 for elaboration). Regarding the group formation project more specifically, our data suggested diminished emotional inertia may underlie the capacity of alcohol to improve affective states (Fairbairn & Sayette, 2013). Further, as detailed below when considering gender, alcohol's effects on emotional contagion (Fairbairn, Sayette, Aalen, & Frigessi, 2015a) may help to explain the impact of alcohol on emotion in a social context. With respect to moderators, the following sections address three individual difference factors that have been examined in our group formation project.

**2.2.1. Personality**—While the elusive “alcoholic personality” has been discussed for decades (see Sher et al., 1999), interest in this topic has grown in recent years. With the design of longitudinal studies that overcame many of the methodological limitations of early cross-sectional research, a set of core personality traits began to emerge that appeared to relate to alcoholism (see Sher et al., 1999). As noted when discussing stress response dampening, experimental studies have examined personality traits thought to moderate the putative reinforcing effects of alcohol. Despite the promise of this approach the research thus far offers inconsistent evidence regarding the relation between personality traits and the reinforcing effects of alcohol (Sher & Wood, 2005). Along with inadequate sample sizes, insensitive measures of personality, and questionable methods for studying alcohol's acute effects (see Sher & Wood, 2005), the absence of a social context in some of these studies may have contributed to these findings.

Much experimental research examining the moderating influence of personality on the effects of alcohol has tested social drinking participants in isolation (e.g., Sayette et al., 2001b; though see; Sher & Walitzer, 1986). Consequently, most studies of person-level moderators of alcohol's effects create atypical conditions. Without considering social context, investigators may have struggled to identify potential moderators of the reinforcing effects of alcohol (Sayette, 1993a). Group settings offer a unique chance to identify individual differences that moderate the reinforcing effects of alcohol, factors that might be missed when testing subjects in isolation (see Doty & de Wit, 1995). In fact, many of the pleasant effects of alcohol that confer increased risk for alcoholism (e.g., increased

sociability) must be studied in a group setting (Cooper, 2002). Despite the importance of contextual variables in the study of individual differences (Sher & Wood, 2005), though, lab research testing the moderating role of personality on alcohol's reinforcing effects until recently has not been conducted in group settings.

Using the group formation project data set, we examined the impact of personality traits on alcohol response in a social context (Fairbairn et al. 2015c). We focused on extraversion, a trait that has attracted considerable attention and is intuitively linked to social environments. Persons high on extraversion were especially sensitive to alcohol's effects on reported mood and social bonding. Moreover, analyses focusing on Duchenne smiling of group members indicated that social processes uniquely accounted for alcohol reward-sensitivity among individuals high in extraversion. Results suggest that alcohol-related reward may be explained by social processes among extraverted drinkers. This pattern points to new directions for understanding the factors that both mediate and moderate the impact of alcohol on emotion in social settings.

**2.2.2. Genetics**—Individual differences in the socially reinforcing effects of alcohol also may relate to genetic makeup, and testing alcohol's effects in a social context may be a powerful approach to uncover genetic vulnerability to alcoholism (Fromme et al., 2004; Volkow & Li, 2004). The group formation project also permitted examination of genetic moderators on alcohol's effects in a social context. Creswell et al. (2012) evaluated an often studied polymorphism in behavioral genetics, consisting of a Variable Number of Tandem Repeats (VNTR) in exon 3 of the gene encoding the dopamine D4 receptor (*DRD4*). The *DRD4* genotype pertains to gene  $\times$  environment interactions involving alcohol-related traits (Larsen et al., 2010). For instance, Park, Sher, Todorov, and Heath (2011) found college/Greek involvement to predict increased risk of alcohol dependence, but only among students with at least one copy of the 7-repeat allele. This research raises questions regarding the mechanisms by which social factors increase risk for problematic drinking among 7-repeat carriers (Park et al., 2011; see also; Mrug & Windle, 2014).

Creswell et al. (2012) tested whether alcohol consumption would differentially promote social bonding in randomly assigned groups varying on *DRD4* genotype. Four hundred twenty-two caucasian participants from the Sayette et al. (2012a) group formation project were genotyped for the *DRD4* VNTR and, within each condition, participants were grouped by presence or absence of the *DRD4* 7-repeat allele (see Creswell et al. 2012 for methodological details). Findings provided initial support for a moderating effect of the *DRD4* polymorphism on the link between alcohol consumption and social bonding. Persons carrying the 7-repeat allele reported increased perceived social bonding after drinking alcohol, relative to placebo and non-alcohol control beverages, while alcohol did not affect perceived social bonding of 7-absent individuals. Research is needed to replicate this candidate gene finding, in a field where replication has been elusive. Nevertheless, use of an experimental design is considered to be critical for further advancement of gene  $\times$  environment studies in psychopathology (Moffitt, Caspi, & Rutter, 2006; Rutter, Pickles, Murray, & Eaves, 2001).

**2.2.3. Gender**—Although Wilson’s initial TRT studies suggested that gender moderated the effects of drinking, his subsequent studies (e.g., Sayette, Breslin, Wilson, & Rosenblum, 1994) and those from other laboratories (e.g., Levenson et al., 1987; Steele & Josephs, 1988) did not tend to reveal alcohol  $\times$  gender interactions (see Fairbairn et al., 2015a; Fairbairn et al., 2015b). Such experimental inconsistencies are surprising when one considers that gender is one of the most potent risk factors for alcoholism, with males being twice as likely as females to evince symptoms (SAMHSA, 2012), a difference often thought to relate to gender differences in alcohol-reward sensitivity (Nolen-Hoeksema, 2004).

Fairbairn et al. (2015a; b) argued that gender differences are most likely to arise when alcohol studies include a social context. Gender differences often emerge selectively in social settings (Eagly, 1995). Social enhancement motives for drinking show the most consistent sex differences (e.g., Cooper, 1994), and rates of heavy drinking are elevated in all-male drinking groups and all-male social organizations (see Fairbairn et al., 2015a). Thus, social drinking paradigms might serve to reveal sex differences in alcohol reward sensitivity. Fairbairn et al. conducted tests examining the moderating impact of gender on alcohol’s socially rewarding effects using both acoustical and facial expression measures.

Parameters of acoustic output have been reliably associated with internal affective state. Specifically, when individuals are observed in a relatively pleasant, nonthreatening context, the volume of speech is associated with joy or happiness (see Fairbairn et al., 2015b; Johnstone & Scherer, 2000). Results obtained from the group formation project indicated a moderating role for gender. In particular, alcohol had a differential impact on the volume of social interaction in male groups compared to groups containing females. Sober groups containing females were louder than sober male groups, and alcohol consumption brought the all-male groups up to the level of groups containing females. This study reveals “greater alcohol reward for male groups and thus identifies a mechanism that may support heavy drinking in male drinking contexts” (Fairbairn et al., 2015b, p. 262).

We also used the group formation data set to examine the impact of gender and alcohol on “emotional contagion”—a social mechanism central to bonding and cohesion (Fairbairn et al., 2015a). Specifically, we tested the effect of alcohol and group gender on the probability that an initial smile would develop into a mutual smile. Duchenne smiling (but not non-Duchenne smiling) contagion correlated with enhanced self-reported mood and perceived social outcomes. Importantly, Duchenne smiles were significantly less contagious among sober male groups than female groups, and alcohol eliminated these gender differences in smiling contagion. As noted: “Men derive more reward from alcohol than do women and ... this reward manifested as a specifically social, catching process ... Further analyses revealed that this significant group-level interaction was not driven by the gender of the smile initiator but was instead driven by the gender of the smile initiator’s group-mates—the gender of those who might be infected by a smile. Thus, results indicated that alcohol selectively enhanced the probability that a man will catch a smile in a social-drinking context” (Fairbairn et al., 2015a, pp. 696–697). More broadly these findings suggest that the social rewards associated with alcohol consumption are especially pronounced for male drinkers.

In summary, the group formation project offered a platform by which to evaluate the complex relationship between alcohol and emotion in a social context. Thus far, the research has investigated underlying mechanisms such as emotional inertia and emotional contagion, as well as the moderating role of gender, genes, and personality. The studies suggest that certain individuals are particularly sensitive to alcohol's socially reinforcing effects and possibly for different reasons. Certainly research is needed to continue to examine additional mediators and moderators.

### 3. Conclusions

Studying the effects of alcohol on emotion seems like a straightforward endeavor, as nearly everyone appears to believe that we drink to feel better. Yet regardless of whether the outcome is stress relief or enhancement of positive emotion, the laboratory has been reluctant to deliver the confirming data we have expected. It has long been out of favor to declare that alcohol directly and invariantly affects emotional states. Narrow learning-based analyses of the alcohol—emotion association have yielded to approaches that integrate advances derived from the study of cognition, affect, and social processes.

After a flurry of expectancy data suggested placebo beverages affected anxiety, the research pendulum has swung back toward an emphasis on pharmacological effects. In contrast to initial TRT pharmacological accounts, however, current models suggest that at moderate doses alcohol affects emotion indirectly via its effects on cognitive processes.<sup>8</sup> In this sense, the cognitive revolution continues to influence the way in which alcohol researchers view alcohol and emotion. Moreover, the emergence of research on implicit cognition and addiction (Wiers & Stacy, 2006) suggests that not only alcohol consumption, but also anticipation of alcohol (and other drug) consumption can affect cognition (Sayette & Creswell, 2016).

Advances in emotion science also have made an impression on the way in which alcohol researchers conduct their studies (see Curtin & Lang, 2007). The integration of measures that can unobtrusively, objectively, and reliably capture emotion in real time (e.g., FACS) has opened new pathways for understanding the dynamic effects of alcohol in social situations. Moreover, substantial progress has been made applying advances in psychophysiology and neurobiology to incorporate theoretically meaningful measures to study the impact of alcohol on emotion (Bartholow, Henry, Lust, Saults, & Wood, 2012; Curtin & Lang, 2007; Mitchell, Gillespie, & Abu-Akel, 2015).

While social context has been considered in alcohol studies for many years (Pliner & Cappell, 1974; Wilson, 1978), only recently have paradigms been developed that apply theory and methods drawn from small groups research. This research is just beginning to take hold, but the findings described in the previous section suggest that alcohol's effects on emotion may be fairly robust when tested among strangers in an unstructured environment.

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<sup>8</sup>At high doses of alcohol, there is some evidence that alcohol may have a direct stress response dampening effect (see Curtin & Lang, 2007).

The group formation project also revealed mediators and moderators of alcohol's effects on emotion in a social context.

Social learning theory is rarely mentioned in current studies examining the impact of acute alcohol administration on emotion. Yet the key points of emphasis brought to the fore during the 1970s and 1980s have been swallowed whole. The assessment of anxiety has progressed well beyond single self-report instruments and is likely to continue to embrace advances in cognitive and affective sciences including both behavioral and neurobiological approaches. So too is there heightened recognition that anxiety does not occur in a vacuum, and that particular environmental contexts must be considered when developing and testing new theories.

#### 4. Future directions

Research is needed that examines alcohol's effects on emotion throughout the entire drinking episode. In an effort to offer maximal control too often investigators have relied on experimental drinking intervals that may not resemble the experience of a typical social drinker. For instance, drinking to intoxication in 20 min, waiting 20 extra minutes for absorption, and then performing a task unlikely captures a typical evening of social drinking that includes differences across not only the limbs of the BAC curve (Babor, Berglas, Mendelson, Ellingboe, & Miller, 1983), but differences in the rate of acceleration or deceleration within each limb. [Of course, alternative drinking approaches such as that used in the group formation project also raise methodological complexities. Ultimately, a broad range of drinking behavior sequences may prove optimal.] Research also is needed to revisit the conditions under which alcohol may exacerbate a stress response (perhaps through impaired coping efforts). This issue has emerged in various theories (Curtin et al., 1998; Sayette, 1993a; Steele & Josephs, 1988), but there likely is benefit to systematic investigation of this phenomenon.

Research on gender differences in substance abuse has remained of interest for decades (Evans & Reynolds, 2015; Wilson, 1987b). This research is at its best when there are theory-driven hypotheses associated with gender to test. Men and women need not differ *de facto* in their response to alcohol across all domains. As noted earlier, when discussing the group formation project, social environments would appear to provide fertile conceptual ground for investigating gender differences. Similarly, inclusion of a social context may prove useful for better identifying ethnic differences in response to alcohol (Fairbairn et al., 2013). Little research has considered age as a moderator of alcohol's effects on emotion, and this variable also represents a fruitful target for examination.

##### 4.1. Cognition

The view that much of the emotion-altering effects of drinking are expectancy-based, which was popular in the late 1970's, is on the wane. Yet complete dismissal of dosage-set effects of drinking may be premature, especially as interest in placebo responding in general has arisen in other areas of science and medicine (Kirsch, 1999). Research indicates that placebo beverages can lead individuals to draw upon greater cognitive resources, and in some cases improve performance (Bailey, Bartholow, Sauls, & Lust, 2014; Marczinski & Fillmore,

2005; Sauls et al., 2007; Vogle-Sprott & Fillmore, 1999). In addition, nonpharmacological drinking factors still occasionally appear to affect social behavior (Hull & Bond, 1986; Sayette, Dimoff, Levine, Moreland, & Votruba-Drzal, 2012b), and research is needed to evaluate how expectancies related to drinking may affect group processes. Work by Goldman et al. (e.g., Moltisanti, Below, Brandon, & Goldman, 2013) has begun to examine the impact of alcohol expectancy primes on social bonding. Part of the challenge in this realm is that researchers have run up against methodological obstacles regarding just what can and cannot be controlled for in a placebo beverage (see Martin & Sayette, 1993). Consideration of alternative (including implicit) approaches to assessing dosage-set may be useful. Moreover, the intersection of placebo deception effectiveness and social processes (placebo contagion effects, conformity, etc.) require examination. Though at first glance participants consuming placebo beverages in our group formation project do not appear to respond in an obviously distinct way when compared to those in our prior studies who consumed placebos while alone, we continue to evaluate this possibility.

While placebo manipulations have been less associated with emotional responses in recent alcohol studies, cognitive processing more generally remains of interest. Recent studies illustrate the increasingly sophisticated approaches to testing the impact of alcohol on cognitive processes. This interdisciplinary research is informed by neurobiological and electrophysiological research and methods on the one hand, and by cognitive psychological theories and tasks on the other. To offer just a few examples, this research has aimed to disentangle the impact of alcohol on processes such as task switching, sustained attention, controlled versus automatic processing, conflict monitoring, performance adjustment, mind-wandering, and various aspects of working memory (e.g., Bailey et al., 2014; Bartholow et al., 2012; Curtin & Fairchild, 2003; Curtin & Lang, 2007; Fillmore, Vogel-Sprott, & Gavrilescue, 1999; Kirchner & Sayette, 2003; Ridderinkhof et al., 2002; Sauls et al., 2007; Sayette, Reichle, & Schooler, 2009; Sher et al., 2007). Together, this sampling of studies reveals that alcohol's effects on cognitive processes in fact echo the complex, context-specific effects of alcohol on emotion. This is not altogether surprising given the interconnections between cognitive and affective systems. Of particular importance is the need to continue to develop methods for assessing cognitive and affective processes simultaneously (Curtin & Lang, 2007). The findings from such a wide range of measures suggest that diverse models of alcohol are likely necessary to explain the various ways in which alcohol affects cognitive and emotional experiences (Fairbairn & Sayette, 2014).

#### 4.2. Social processes

Clearly additional studies conducted across laboratories are needed to replicate and expand the group formation project findings discussed here. Research in which participants receive different beverages (e.g., alcohol, placebo, control) within a single group would evaluate critical questions regarding the match between an individual and the rest of his/her group regarding perceived intoxication (Sayette et al., 2016). Disentangling intoxication effects between actors and partners is not merely an academic exercise; such beverage mismatches also occur outside the lab (e.g., designated drivers at parties). Research has targeted this question using dyads (e.g., Connors & Sobell, 1986; Doty & de Wit, 1995; Kirkpatrick & de Wit, 2013), suggesting that it is not simply the state of the drinker but also (echoing Wilson



et al., 1981) the state of their partners that influence the effects of alcohol. In addition, much drinking occurs in environments in which group members already are acquainted, and research testing the effects of alcohol among friends and acquaintances is warranted. Research examining intimate partner interactions during drinking, for example, represents an important line of inquiry (Leonard & Roberts, 1998; Testa, Crane, Quigley, Levitt, & Leonard, 2014).

While our group formation interaction generally [though not entirely (see Fairbairn et al., 2013)] elicited positive experiences, group research introducing manipulations that might permit shifts in the affective tone of the interaction would offer varied social contexts for examining the impact of alcohol. For instance, asking participants to reach agreement on a group decision that purportedly has actual consequences [e.g., coming to consensus on a group decision involving ostensibly real implications (Sayette et al., 2012b)] or use of social exclusion manipulations (Hales, Williams, & Eckhardt, 2015) may provide less benign circumstances to examine. We currently are examining ostracism effects in the group formation project.

In sum, when studied in a social context alcohol appears to enhance social bonding. Such findings accord with animal models that also suggest that moderate doses of ethanol enhance social functioning (Blanco-Gandia, Garcia, Garcia-Pardo, Montagud-Romero, & Rodriguez-Arias, 2015). Human alcohol research that incorporates social context into their designs holds promise for understanding the underlying mechanisms that mediate these effects of alcohol and offers insight regarding individual differences that may moderate alcohol's effects. Such research should not be confined, of course, to the laboratory and, as sophisticated applications of ecological momentary assessment of drinking have emerged in recent decades (e.g., Collins et al., 1998), they are certain to offer important advances in our understanding of alcohol's effects on social and emotional processes.

### 4.3. Emotion

As emphasized by Wilson and Marlatt, there remain limitations to exclusive reliance on self-report emotion measures when considering the impact of alcohol in individuals or in groups. Emotional experiences are dynamic and require fine-grained temporal assessment that has been missing from the self-reported instruments typically found in alcohol studies (see Fleming et al., 2013; Levenson, 1987; Sayette et al., 2012a). As noted by Curtin and Lang (2007), there is a need to investigate the effects of alcohol on the various components of emotional responding, including “response threshold, peak intensity, duration, subsequent regulatory processes” (p. 207). When incorporating social context into the research, the use of a dynamic multimodal approach to emotion assessment is especially warranted. Some of the most intriguing findings in our group formation project stemmed from fairly unobtrusive measures of facial expression, speech, and acoustic patterns (Fairbairn et al., 2015a, 2015b, 2013; Fairbairn & Sayette, 2013; Sayette et al., 2012a). Unfortunately, micro-analytic facial coding of such large, multimillion-frame databases using human coders is admittedly a prohibitive endeavor, which likely has discouraged this sort of measurement in the past. It is promising to note, however, recent advances in the automated coding of facial behavior, including work using the group formation data set (e.g., Cohn & Sayette, 2010; Girard,

Cohn, Jeni, Sayette, & De la Torre, 2015), and it is becoming feasible to conduct large scale facial coding efforts. In addition to facial coding, there has been recognition that certain psychophysiological measures (e.g., pulse rate), while convenient to use, may be suboptimal for assessing the acute effects of alcohol on stress (see Sayette, 1993b). Novel approaches to the analysis of psychophysiological data have benefitted this field (e.g., Sher et al., 2007). More generally, advances in the psychophysiological, neurobiological, and neurogenetic assessment of emotion will continue to help develop the next generation of theories of alcohol and emotion (Curtin & Lang, 2007).

With few exceptions (e.g., Donohue, et al., 2007; Ruch, 1993; Stritzke, Patrick, & Lang, 1996; Vuchinich, Tucker, & Sobell, 1979; Weaver, Maslund, Kharazmi, & Zillman, 1985), there has been little investigation of the impact of alcohol on responses to positive stimuli. Positive responding may be especially important to study in a social context, and my colleagues and I are currently completing analyses on a group study that includes a comedy routine manipulation.

## 5. Clinical implications

Conger's (1956) TRT was never quite as simple as it often has been portrayed. For instance, although he concluded that alcohol usually will reduce tension, he also acknowledged that in some cases alcohol might increase tension—in circumstances where “restraining tendencies are initially so great that a person never comes close enough to ... be aroused” (p. 303). Certainly subsequent research has continued to point to complex relations between alcohol and emotion. Yet so too has real progress been made identifying particular circumstances in which individuals will generally find relief or reward from drinking alcohol. Recent studies also are gaining traction identifying individual difference factors that moderate these emotional effects on alcohol. This work has largely been conducted using social drinkers and presumably offers insight into factors that may lead individuals to begin to develop often benign drinking habits. These person-level differences also may prove useful, however, in developing models to understand who is most likely to transition from a “normal” drinking habit to a drinking problem.

It is appropriate to revisit the reasons that social learning theory—and its close cousin, cognitive-behavioral therapy—took an interest in the TRT. From a social learning perspective, the accumulating data on the effects of alcohol support a key role for emotion and for emotion regulation as causes and consequences of drinking, and suggest reasons for the high co-occurrence of alcohol use and anxiety disorders. As Wilson (1982) counseled, because drinking alcohol can be reinforcing for certain people in certain circumstances (e.g., those who struggle with general coping skills and with social skills deficits), we can work clinically to address ways in which these benefits can be derived from healthier activities. Cognitive-behavioral therapists can focus on a drinker's alcohol expectancies (Darkes & Goldman, 1998) and his or her ability to cope with daily stressors. Clinicians also can address with their problem drinking clients factors such as cultural attitudes and role models that affect their responses when drinking. Finally, recognizing the intersection of individual differences and social psychological factors [e.g., intoxicated participants who were more likely to “catch” a partner's smile were more likely to report being heavier drinkers outside

the laboratory (Fairbairn et al., 2015a)] opens up new avenues for discussion with patients. If replicated, interventions may profitably target social reward as a mechanism underlying the development of problematic drinking in young adults. The traditional gap between the laboratory and clinic lamented by Wilson (1987b) remains today, yet there is reason to hope that recent theory development and data acquisition regarding the effects of alcohol on emotion offer prospects for an improved translation of research into practice.

## Acknowledgments

This article appears in a special issue recognizing the enormous contributions by G. Terence Wilson to the field of behavior therapy, and to this journal as its longtime editor. I am indebted to Dr. Wilson for his mentorship during my graduate training in his *Alcohol Behavior Research Laboratory (ABRL)*. His capacity to master, critique, and then integrate basic theories and research on human behavior with his astute clinical impressions marks him as one of the premier scientist-practitioners in our discipline, and has enabled him to make singular contributions to the field of clinical psychology. As a graduate student, I was struck by his near encyclopedic grasp of the behavioral alcohol research literature and his incisive skills regarding experimental design. I was most inspired, though, by his willingness to allow the data to inform our positions, even in cases in which new results did not support the findings of his earlier studies. As this manuscript documents, Dr. Wilson's empirical studies and his reviews of the tension reduction literature created a pivot point for this area of research, ushering in a more nuanced understanding of the impact of drinking on emotional states that continues to influence research decades after the ABRL shut its doors.

I also am grateful to the staff members, students, and former students at the *Alcohol and Smoking Research Laboratory* at the University of Pittsburgh, with whom I have collaborated on many of the studies described herein. In particular, I thank Kasey Creswell and Catharine Fairbairn, who played critical roles analyzing the group formation data and investigating potential mediators and moderators of the effects of alcohol on emotion. I also appreciate the valuable contributions to the group formation research provided by John Dimoff, Thomas Kirchner, and Bryan Heckman, as well as colleagues Jeff Cohn, John Levine, and Richard Moreland. The alcohol-group formation project was funded by the National Institute on Alcohol Abuse and Alcoholism (R01 AA015773) and preparation of this manuscript was supported in part by the National Cancer Institute (R01 CA184779).

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